



# Standard Practice for Determining the Capacity of Oxygen Removal Ion Exchange Cartridges<sup>1</sup>

This standard is issued under the fixed designation D7903; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon ( $\epsilon$ ) indicates an editorial change since the last revision or reapproval.

## 1. Scope

1.1 This practice covers the determination of the performance of oxygen removal ion exchange resin cartridges in the regenerated form when used for removing dissolved oxygen from water. The test can be used to determine the initial capacity of unused cartridges or the remaining capacity of used cartridges. In this case, performance is defined as oxygen removal capacity (or throughput) to a defined endpoint.

1.2 The values stated in SI units are to be regarded as standard. No other units of measurement are included in this standard.

1.3 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

## 2. Referenced Documents

2.1 *ASTM Standards:*<sup>2</sup>

D888 Test Methods for Dissolved Oxygen in Water

D1129 Terminology Relating to Water

D1193 Specification for Reagent Water

## 3. Terminology

3.1 *Definitions*—For definitions of terms related to water, refer to Terminology D1129.

## 4. Summary of Practice

4.1 This practice will evaluate the capacity of an oxygen removal cartridge for water by running a test solution of known oxygen content through a cartridge to a specified endpoint. The volume will enable a determination of the capacity for the cartridge to remove dissolved oxygen in water.

<sup>1</sup> This practice is under the jurisdiction of ASTM Committee D19 on Water and is the direct responsibility of Subcommittee D19.08 on Membranes and Ion Exchange Materials.

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<sup>2</sup> For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

## 5. Significance and Use

5.1 This practice can be used to evaluate unused oxygen removal ion exchange cartridges for conformance to specifications.

5.2 This practice provides for the calculation of capacity in terms of the volume of water treated to an end point level of dissolved oxygen.

5.3 The practice as written assumes that the oxygen removal ion exchange resins in the cartridge are either partially or fully regenerated. Regeneration of the resins is not part of this practice.

5.4 This practice provides for the calculation of capacity on a cartridge basis.

5.5 This practice may be used to test different size oxygen removal resin cartridges. The flow rate of test water and the frequency of sampling are varied to compensate for the approximate volume of resin in the test cartridge.

## 6. Apparatus

6.1 *Test assembly* (Fig. 1), consisting of the following:

6.1.1 *Cartridge*, and *pressure vessel*, if required. Connections shall be provided at the top and the bottom for the admission and removal of the exhausting solution as described in 8.3, 8.4, and 8.5.

6.1.2 *Test solution tank*. Adequate means of regulating and measuring flow through the cartridge shall be provided. If the test flow rate (8.2) cannot be obtained by gravity feed, then a pump should be used. Make sure all fittings, connections, and wetted pump portals are secure and tight to the atmosphere.

6.1.3 Measuring oxygen levels of the water in the input and the output of the test cartridge in accordance with Test Methods D888. A continuous recorder is recommended.

## 7. Reagents

7.1 *Purity of Reagents*—Reagent grade chemicals shall be used in all tests. Unless otherwise indicated, it is intended that all reagents shall conform to the specifications of the Committee on Analytical Reagents of the American Chemical Society,

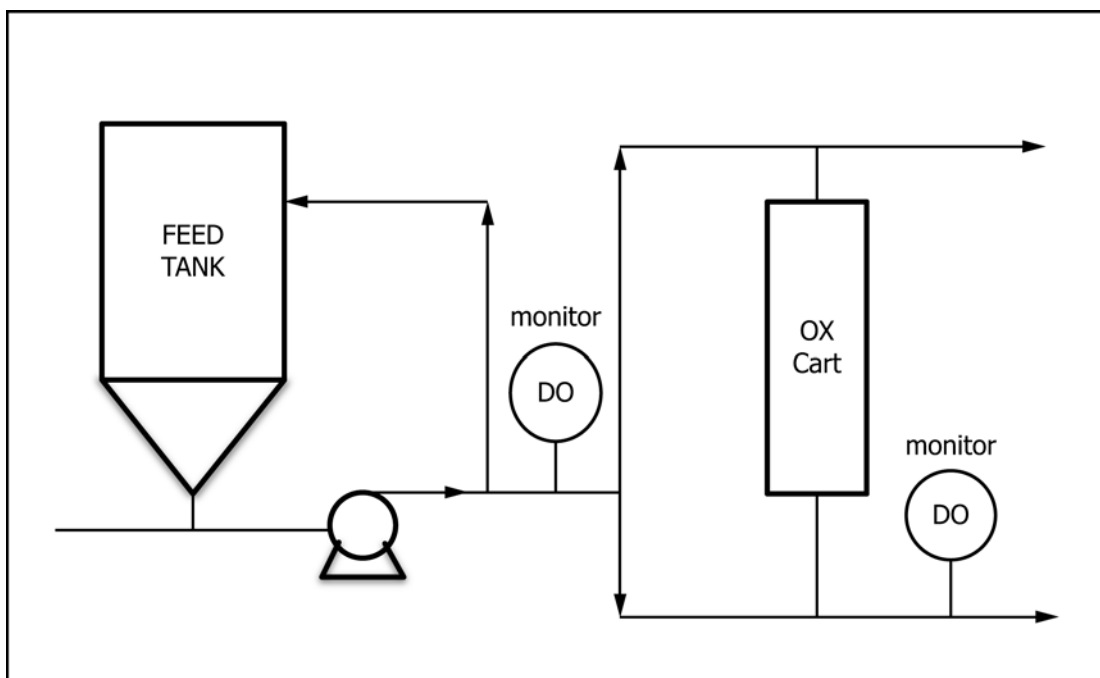


FIG. 1 Typical Apparatus for Performance Testing of Oxygen Removal Ion Exchange Cartridges

where such specifications are available.<sup>3</sup> Other grades may be used, provided it is first ascertained that the reagent is of sufficiently high purity to permit its use without lessening the accuracy of the determination.

7.2 *Purity of Water*—All reference to water in this practice shall be understood to mean Reagent Water Type I or II conforming to Specification D1193, with the additional requirement that the silica concentration is less than 0.1 mg/L.

7.3 *Dissolved Oxygen Ion Exchange Test Water D*—Prepare the test water by filling tank with Reagent Water Type I or Type II and aerate to equilibrate the dissolved oxygen levels. Calculate the theoretical level of saturated oxygen based on temperature and pressure, and when this level has been reached stop the aeration process. Let the test water sit for at least 6 to 8 hours and check the dissolved oxygen level. If there is a significant reduction there may be an oxygen demand from biochemical oxygen demand (BOD) contamination. If the dissolved oxygen level has remained stable you may proceed with the test. A continuous monitor of the dissolved oxygen levels in the test water must be maintained throughout the practice.

7.3.1 A single test requires approximately 1000 L of this solution for each litre of oxygen removal ion exchange resin that a cartridge contains assuming dissolved oxygen levels close to complete saturation.

## 8. Procedure

8.1 Measure the outside diameter and length of the ion exchange cartridge. Calculate the overall cartridge volume (in litres) as follows:

$$V_c = \frac{[\pi D^2 L]}{(4)(1000)} \quad (1)$$

where:

$D$  = cartridge diameter, in cm, and

$L$  = cartridge length, in cm.

8.2 Using the cartridge volume calculated in 8.1, calculate the test flow rate (in mL/min) as follows:

$$Q = 30\rho V_c \quad (2)$$

where:

$V_c$  = cartridge volume, in litres.

NOTE 1—For multi-tube cartridges the volume is the sum of the volumes of all the tubes.

8.3 Slowly introduce Reagent Water at the bottom of the cartridge until the cartridge is full. Allow water to stand in the cartridge for ¼ hour to “condition” the resin prior to the test. Expel all air before proceeding.

8.4 Slowly introduce Test Water D. Increase the flow rate  $Q$  to the value determined in 8.2, adjusting the rate as required with a valve or other flow restriction in the effluent line.

8.5 Measure and record the influent and effluent dissolved oxygen levels each volumetric increment equal to  $50 V_c$ . Continue until the effluent dissolved oxygen value reaches ½ the influent dissolved oxygen value, then record the total volume of test water processed ( $V_T$ ) in litres.

<sup>3</sup> *Reagent Chemicals, American Chemical Society Specifications*, American Chemical Society, Washington, DC. For suggestions on the testing of reagents not listed by the American Chemical Society, see *Analar Standards for Laboratory Chemicals*, BDH Ltd., Poole, Dorset, U.K., and the United States *Pharmacopoeia and National Formulary*, U.S. Pharmacopoeial Convention, Inc. (USPC), Rockville, MD.

## 9. Calculation

9.1 The operating capacity is calculated on a cartridge basis using a dissolved oxygen end point equal to one half the dissolved oxygen level of the feed water.

9.2 Calculate the operating capacity to the dissolved oxygen end point as follows:

$$\text{Capacity, grams of oxygen removed/cartridge} = C \times V_T \quad (3)$$

where:

$C$  = total dissolved oxygen in Test Water D expressed in grams per litre as described in 7.3,

$V_T$  = volume of test water used, per cartridge, litres,

NOTE 2—Other end points may be agreed upon. When this is done the species and level selected should be specified with the results.

## 10. Report

10.1 The report of results of this practice should include not only the capacity as calculated above but the end point used. For certification purposes the averaging of results from three separate samples is customary.

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## 11. Precision and Bias

11.1 Refer to Test Method D888 for precision and bias in dissolved oxygen measurements.

## 12. Quality Control

12.1 In the analysis of ion exchange resins, it is not possible to prepare a known standard resin for comparison with the actual samples. Therefore it is impossible to test the accuracy of the results, and this practice does not include a bias statement.

12.2 The cartridge effluent is analyzed in accordance with Test Methods D888. Such analyses are subject to the quality control requirements of the referenced methods.

## 13. Keywords

13.1 cartridge capacity; dissolved oxygen; ion exchange; oxygen removal cartridge